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(56) Documents cited
GB 1459423 A GB 0537433 A US 4629924 A

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INT CL[5] H02K 7/116 37/16

(54) Drive unit comprising a stepping motor and gear transmission

(57) A drive unit comprises a housing including a gear wheel transmission 101 and a stepping motor having a stator (1) with two juxtaposed stator sectors (7A, 7B) and a rotor (3) having a radially magnetised permanent-magnet rotor body (3A) which can be rotated about an axis of rotation (11). Each stator sector comprises a set of stator teeth (7A11, 7A21; 7B11, 7B21) arranged as an arc of circle, teeth of one set being interposed between teeth of the other set for each stator sector. Each stator sector further comprises a stator coil (13A, 13B) which is arranged between stator parts and has a coil axis (13A1, 13B1) extending parallel to the eccentric axis of rotation. Both coils are arranged directly adjacent each other at the same side of the rotor body and comprise coil wires connected directly to aligned connectors (21A1, 21A2; 21B1, 21B2).

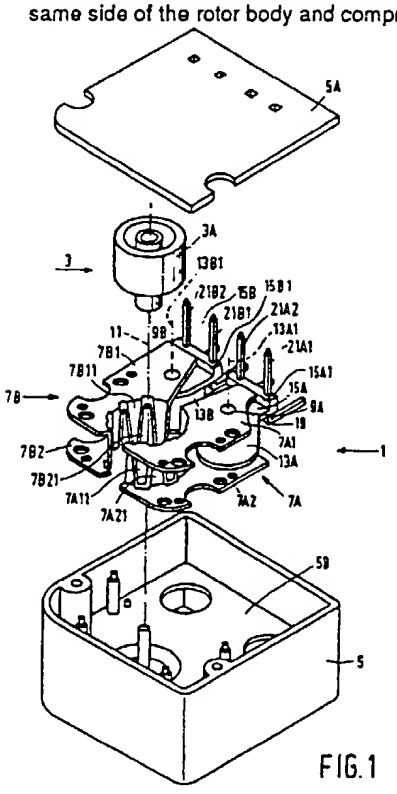

FIG.1

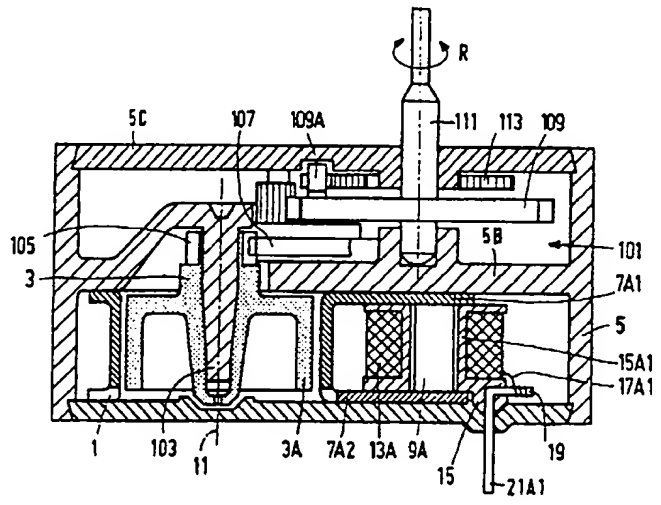

FIG.4

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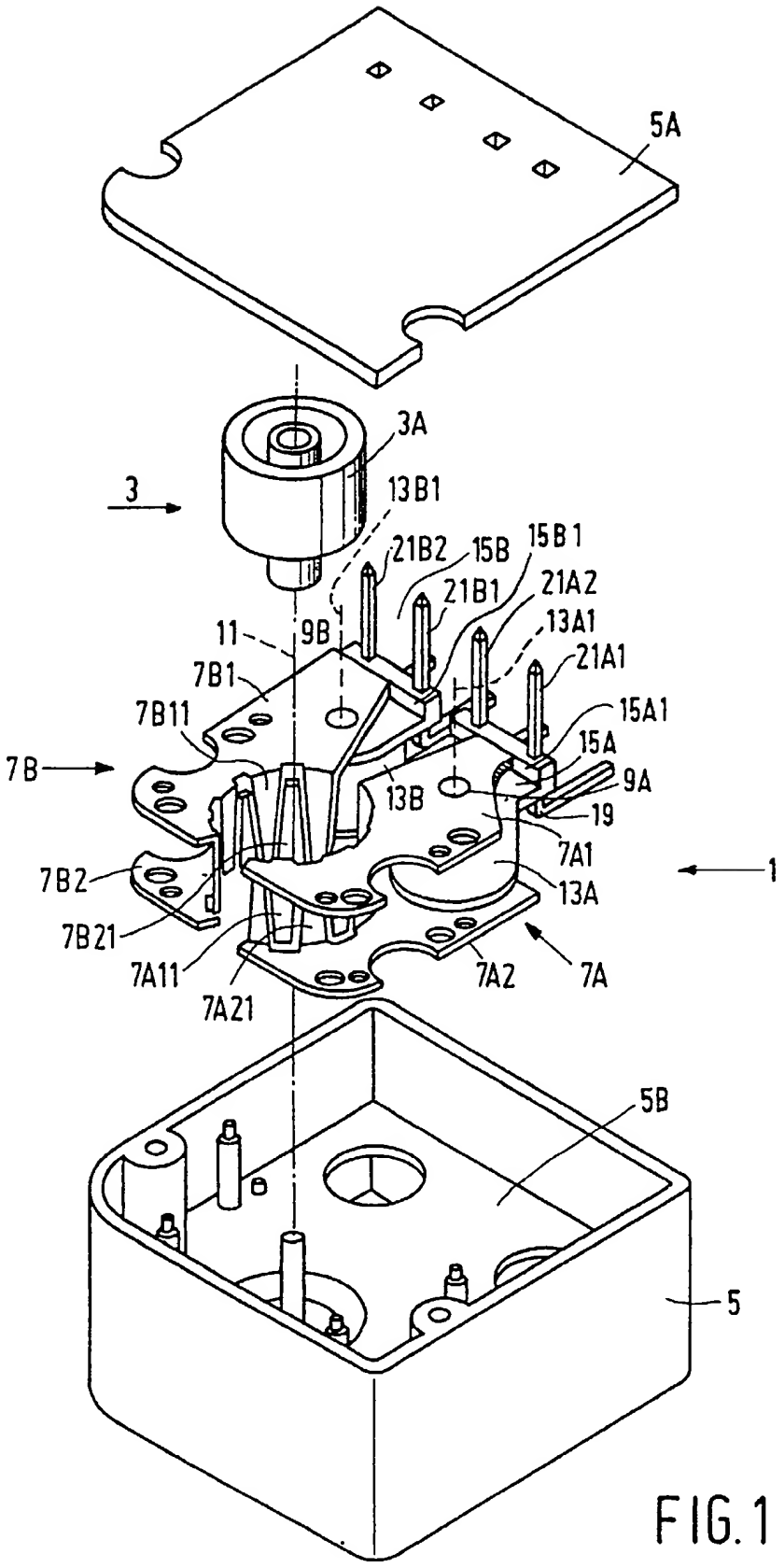
5A
3A
3
13B1
21B2
15B
15B1
21B1
21A2
13A1
21A1
11
9B
7B1
7B11
15A1
15A
7B
9A
13B
19
7A1
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7B2
13A
7B21
7A11
7A21
7A2
7A
5B
5

FIG.1

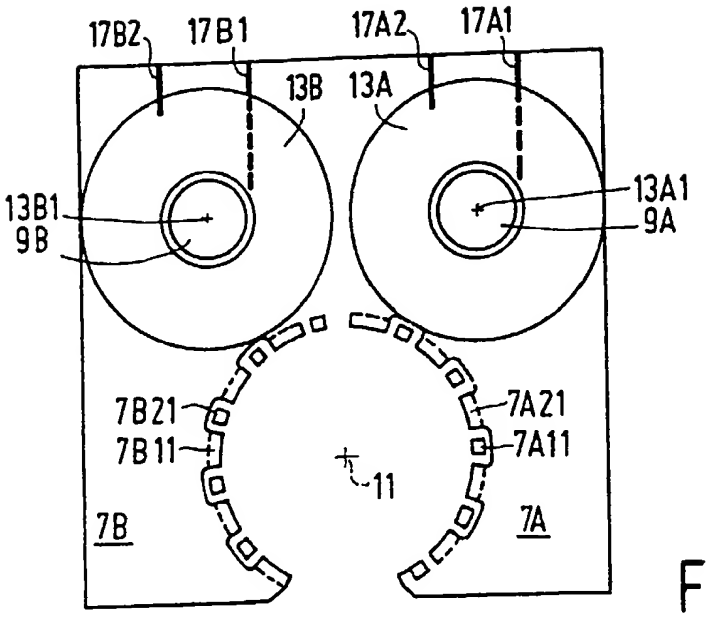
17B2
17B1
17A2
17A1
13B
13A
13B1
9B
13A1
9A
7B21
7B11
7A21
7A11
11
7B
7A

FIG.2

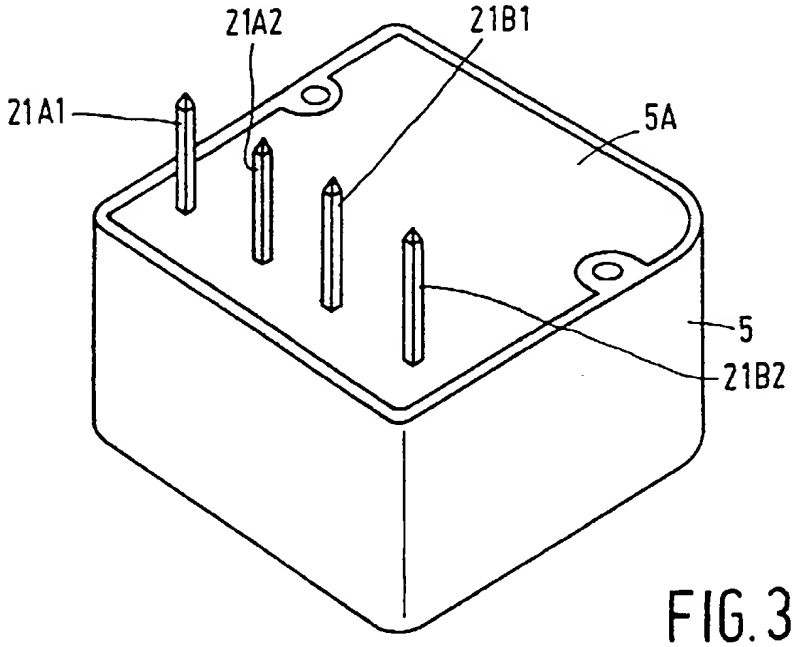
21A2
21B1
21A1
5A
5
21B2

FIG.3

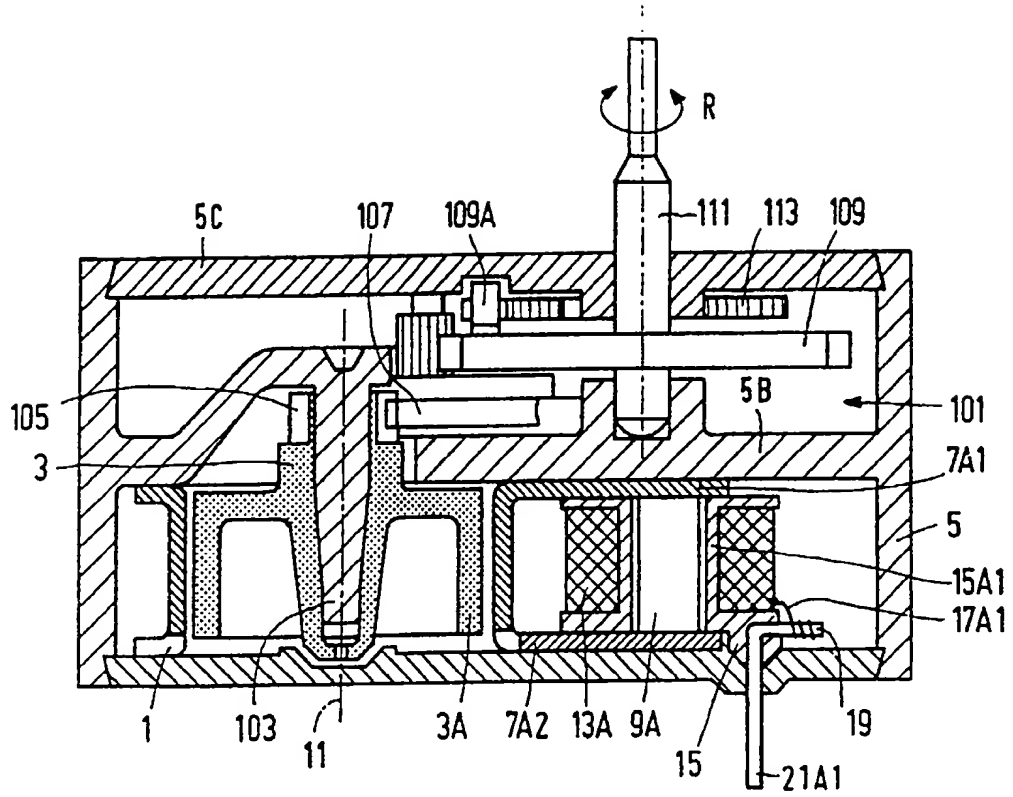
R
5C
107
109A
111
113
109
105
5B
101
3
7A1
5
15A1
17A1
1
103
11
3A
7A2
13A
9A
15
19
21A1

FIG.4

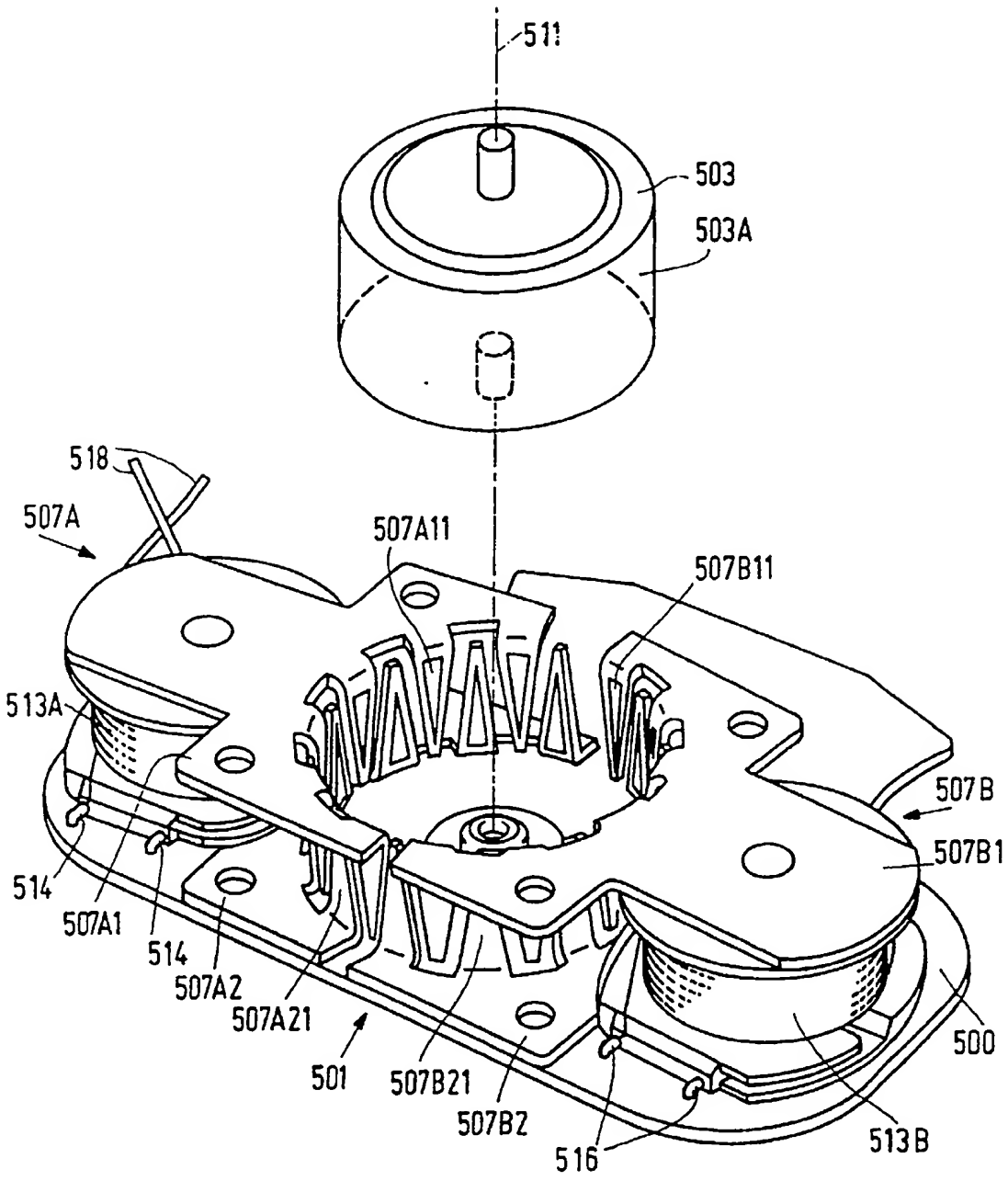
511
503
503A
518
507A
507A11
507B11
513A
507B
507B1
514
507A1
514
507A2
507A21
501
507B21
507B2
516
513B
500

FIG.5

Drive unit comprising a stepping motor

The invention relates to a drive unit comprising a stepping motor having a stator and a rotor, the stator comprising two juxtaposed stator sectors each having two stator parts which each comprise a system of stator teeth arranged as an arc of circle, teeth of one system being interposed between teeth of the other system in each stator sector, the collective stator teeth, which are arranged in a circle, surrounding a rotor body which is rotatable about an axis of rotation and has permanent-magnetic poles facing the stator teeth, stator teeth and magnetic poles cooperating with each other *via* an air gap during operation, and each stator sector comprising a stator coil which is arranged adjacent the rotor body and between the stator parts of a relevant stator sector and which has a coil axis extending parallel to said axis of rotation.

Such a driving unit having a stepping motor arranged on a printed circuit board has been proposed previously. In the known stepping motor the stator coils are arranged on each side of the rotor body and are positioned at least substantially diametrically with respect to the axis of rotation of the rotor body. The known stepping motor has a stator construction of a comparatively small structural height. However, a result of the coil arrangement is that the longitudinal dimension, viewed along a line passing through the coil axes and the axis of rotation, is large with respect to the width dimension extending transversely thereto. In fact, if coils of a large diameter are required a large longitudinal dimension may be the result such that the ratio between the outside dimensions of the motor does not allow certain uses.

It is an object of the invention is to improve the drive unit described in the opening paragraph so as to obtain a compact unit of suitable proportions. Another

object is to obtain a construction which is free from play.

To this end the drive unit in accordance with the invention is characterised in that the drive unit comprises a housing accommodating both the stepping motor and a gear-wheel transmission, the stator parts being secured in the housing and the two stator coils of the stepping motor being juxtaposed at the same side of the rotor body, the gear-wheel transmission being coupled to a gear ring of the rotor and comprising a motor shaft which projects from the housing, a coiled spring being arranged around the motor shaft and acting between the gear-wheel transmission and the housing, and at least one stop being provided between the gear-wheel transmission and the housing to limit the angle of rotation of the motor shaft.

The stepping motor in the drive unit in accordance with the invention may have both a small overall height and a favourable length-width ratio, so that a compact housing of square or substantially square cross-section is possible. The space available in the housing of the stepping motor according to the invention can be used optimally.

It is to be noted that DE 1,488,193 discloses a two-phase synchronous motor having a pair of coils arranged between one main board and two further boards. A rotor body which is rotatable between two stator poles is arranged adjacent the coils.

Due to the special arrangement of the stator coils the drive unit in accordance with the invention provides the possibility of being provided with connector pins in a simple but effective manner. For this purpose the drive unit may be characterised in that the drive unit comprises connector pins which are secured in a holder and project from the housing, one end portion of said connector pins serving as a mounting pin to which one end of a coil wire is secured, the connector pins being arranged in line parallel to each other, and the holder being also constructed as a coil holder for at least one of the stator coils.

The drive unit in accordance with the invention can be electrically connected in a simple manner by means of a suitable connector element.

This embodiment also has the advantage that the holder, which is to be manufactured separately, defines the mutual position of stator coil and connector pins, which facilitates automation of the manufacturing process and enables an optimum dimensioning to be obtained.

An embodiment which is attractive for production reasons is characterised in that the holder comprises a positioning surface cooperating with one of

the stator parts of the stepping motor.

The invention also relates to a holder for use in the drive unit in accordance with the invention.

The invention will now be described in greater detail, by way of example, with reference to the drawings, in which

Figure 1 is a perspective, partly exploded, view of a first the drive unit in accordance with the invention comprising a stepping motor,

Figure 2 shows diagrammatically the mutual position of stator sectors and stator coils of the stepping motor shown in Figure 1,

Figure 3 is a perspective view of the stepping motor shown in Figure 1,

Figure 4 is a cross-sectional view of a second drive unit in accordance with the invention, and

Figure 5 is a perspective view of a previously proposed drive unit.

The stepping motor in the drive unit in accordance with the invention shown in Figures 1,2 and 3 comprises a stator 1, a rotor 3 and an injection-moulded plastics housing 5 having a square cover 5A. The stator 1 comprises two juxtaposed stator sectors 7A and 7B arranged on a square partition 5B of the housing. The stator sector 7A comprises two magnetically conductive asymmetric plate-shaped sector parts or stator parts 7A1 and 7A2 which are connected together mechanically and in a magnetically conductive manner, by means of a connection rod or connection sleeve 9A and which in this example each comprise five stator teeth 7A11 and 7A21 respectively. Likewise, the stator sector 7B comprises two plate-shaped sector parts or stator parts 7B1 and 7B2 connected together by a connector part 9B and each comprising five stator teeth 7B11 and 7B21. The stator teeth 7A11, 7A21, 7B11 and 7B21 are situated in an imaginary cylindrical surface having a cylinder axis 11, in which, viewed in a circumferential direction, the stator teeth 7A11 and 7A21 and the stator teeth 7B11 and 7B21 alternate with each other.

A permanent magnetic rotor body 3A of the rotor 3 is present in the circularly-cylindrical space formed by the collective stator teeth 7A11, 7A21, 7B11 and

7B21. The rotor body 3A, which comprises at its circumferential edge north poles and south poles which alternate with each other in the circumferential direction, is rotatable about an axis of rotation which is eccentric with respect to the stator and which coincides with said cylinder axis 11. In the present example the rotor body 3A has six pole pairs for cooperation with the stator teeth via an air gap.

Each stator sector 7A and 7B in the stepping motor of the drive unit in accordance with the invention comprises an annular stator coil 13A and 13B respectively, which extends around the connector parts 9A and 9B respectively between two stator parts and has coil axes 13A1 and 13B1 respectively parallel to said cylinder axis or axis of rotation 11. The stator coils 13A and 13B are arranged closely, preferably as closely as possible, adjacent one another beside the rotor body 3A, an imaginary connection line situated in a plane oriented perpendicularly to the axis of rotation 11 and passing through the axis of rotation 11 and the coil axes 13A1 and 13B1, forming an equilateral or at least substantially equilateral triangle.

The stator coils 13A and 13B are each formed by winding a coil wire on a coil former of a holder 15A and 15B respectively, the ends 17A1, 17A2 and 17B1, 17B2 respectively of the coil wire being connected to anchoring pins secured in the holders 15A and 15B respectively. The anchoring pins bearing the reference numeral 19 are shown in the drawing. In the present embodiment the juxtaposed holders 15A and 15B, which are preferably manufactured from a plastics material, comprise two connector pins 21A1, 21A2 and 21B1, 21B2 respectively, which have one end portion serving as an anchoring pin. All the connector pins are disposed in line and project from the cover 5A. The holders

15A and 15B further comprise positioning surfaces 15A1 and 15B1 respectively engaging with the stator parts 7A1 and 7B1 respectively.

Beneath the partition 5B the housing 5 accommodates a gear-wheel transmission which is coupled to a gear ring of the rotor and comprises a motor shaft which projects from the housing, a coiled spring being arranged around the motor shaft and acting between the gear-wheel transmission and the housing. At least one stop is provided between the gear-wheel transmission and the housing to limit the angle of rotation of the motor shaft. These items are not visible in Figures 1-3 but are similar to corresponding items in the embodiment of Figure 4, to which reference is now made.

The drive unit in accordance with the invention shown in Figure 4 comprises an integrated gear-wheel transmission which is coupled on the one hand to a rotor and on the other hand to a motor shaft. Parts of this drive unit which correspond to parts of the drive unit shown in Figures 1,2 and 3 bear the same reference numerals.

The drive unit shown in Figure 4 comprises a stepping motor having an injection-moulded housing 5 accommodating a stator 1 having two stator coils, a rotor 3 having a rotor body 3A and a gear-wheel transmission unit 101. The construction of the stator 1 corresponds to that of the stator of the stepping motor shown in Figures 1, 2 and 3; for an elaborate description thereof reference is made to the relevant passages. Figure 4

shows only one stator coil 13A formed on a coil former 15A1 of a holder 15, which coil former is arranged on a shaft-like connection part 9A extending between two stator parts 7A1 and 7A2. The holder 15 comprises connector pins, one of which is referenced 21A1, each comprising an end 19 to which a coil wire 17A1 is anchored.

The housing 5, which also serves as a frame, comprises a partition 5B and an integral bearing journal 103 on which the rotor 3 is supported. The rotor comprises a gear ring 105, which is in engagement with a first gear wheel of the integrated gear-wheel transmission 101. By means of a number of intermediate gear wheels to be derived from the drawing, the first gear wheel 107 is coupled to a last gear wheel 109, which is connected to a motor output shaft 111. The motor shaft 111 projects through a cover 5C and is journalled in the frame. In order to avoid lost motion between the rotor 3 and the motor shaft 111 there is provided a coiled spring 113 which is coaxial with the motor shaft 111 and has one end connected to a projection 109A of the gear wheel 109 and the other end to the housing. For limiting the rotary movement R and for accurately defining an initial position of the motor shaft 111 the projection 109A engages in a groove in the cover 5C, which groove is in the form of an arc of circle, the arc of a circle covering an angle smaller than 360° and the groove ends serving as stops for the projection. The angle of rotation of the rotor shaft can also be limited by means of a projection arranged on a gear wheel and cooperating with a projection on the housing.

The stepping motor shown in Figure 5 comprises an elongate printed circuit board 500, a stator 501 secured to the printed circuit board, and a rotor 503. The stator comprises two juxtaposed stator sectors 507A, 507B, each having two sector parts 507A1, 507A2 and 507B1, 507B2 respectively. Each sector part 507A1, 507A2, 507B1 and 507B2 comprises teeth 507A11, 507A21 ,507B11 and 507B21 respectively, which are arranged relative to each other in the manner shown in the drawing. The rotor 503, which has a radially magnetised permanent-magnet rotor body 503A and can rotate about an axis of rotation 511, is disposed centrally in the motor. Diametrically situated stator coils 513A and 513B having coil wires secured to anchoring pins 514 and 516 respectively are arranged between the sector parts 507A1 and 507A2 and the sector parts 507B1 and 507B2. The anchoring pins are electrically connected, *via* the printed conductors of a printed circuit board, to connection wires 518, which serve for the connection of the stepping motor to a voltage source.

It is to be noted that the invention is not restricted to the exemplary embodiments shown herein. For example, stepping motors having more or fewer stator teeth than the number shown also fall within the scope of the present invention.

CLAIMS:

1. A drive unit comprising a stepping motor having a stator and a rotor, the stator comprising two juxtaposed stator sectors each having two stator parts which each comprise a system of stator teeth arranged as an arc of circle,

- teeth of one system being interposed between teeth of the other system in each stator sector,
- the collective stator teeth, which are arranged in a circle, surrounding a rotor body which is rotatable about an axis of rotation and has permanent-magnetic poles facing the stator teeth, stator teeth and magnetic poles cooperating with each other *via* an air gap during operation, and
- each stator sector comprising a stator coil which is arranged adjacent the rotor body and between the stator parts of a relevant stator sector and which has a coil axis extending parallel to said axis of rotation,

characterised in that the drive unit comprises a housing accommodating both the stepping motor and a gear-wheel transmission, the stator parts being secured in the housing and the two stator coils of the stepping motor being juxtaposed at the same side of the rotor body, the gear-wheel transmission being coupled to a gear ring of the rotor and comprising a motor shaft which projects from the housing, a coiled spring being arranged around the motor shaft and acting between the gear-wheel transmission and the housing, and at least one stop being provided between the gear-wheel transmission and the housing to limit the angle of rotation of the motor shaft.

2. A drive unit as claimed in Claim 1, characterised in that the drive unit comprises connector pins which are secured in a holder and project from the housing, one end portion of said connector pins serving as a mounting pin to which one end of a coil wire is secured, the connector pins being arranged in line parallel to each other, and the holder being also constructed as a coil holder for at least one of the stator coils.

3. A drive unit as claimed in Claim 2, characterised in that the holder comprises a positioning surface cooperating with one of the stator parts of the stepping motor.

4. A drive unit as claimed in Claim 1 or 2, characterised in that the housing is an injection-moulded product and comprises a partition with an integral bearing journal which supports the rotor.

5. A holder for use in a drive unit as claimed in Claim 2 or 3.

6. A drive unit substantially as described herein with reference to Figures 1 to 3 of the drawings or to Figure 4 of the drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

9121423.9

Relevant Technical fields

(i) UK Cl (Edition K) H2A (AKH1, AKX1, AKR7)

(ii) Int Cl (Edition 5) H02K 7/116, 37/16

Search Examiner

J COCKITT

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

27 NOVEMBER 1991

Documents considered relevant following a search in respect of claims 1-6

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1459423 A (SMITHS) see figures 1,2	Claim 1 at least
X	GB 0537433 A (CRABTREE) see stator construction and coil axis	Claim 1 at least
X	US 4629924 A (GROSJEAN) see stator assembly	Claim 1 at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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